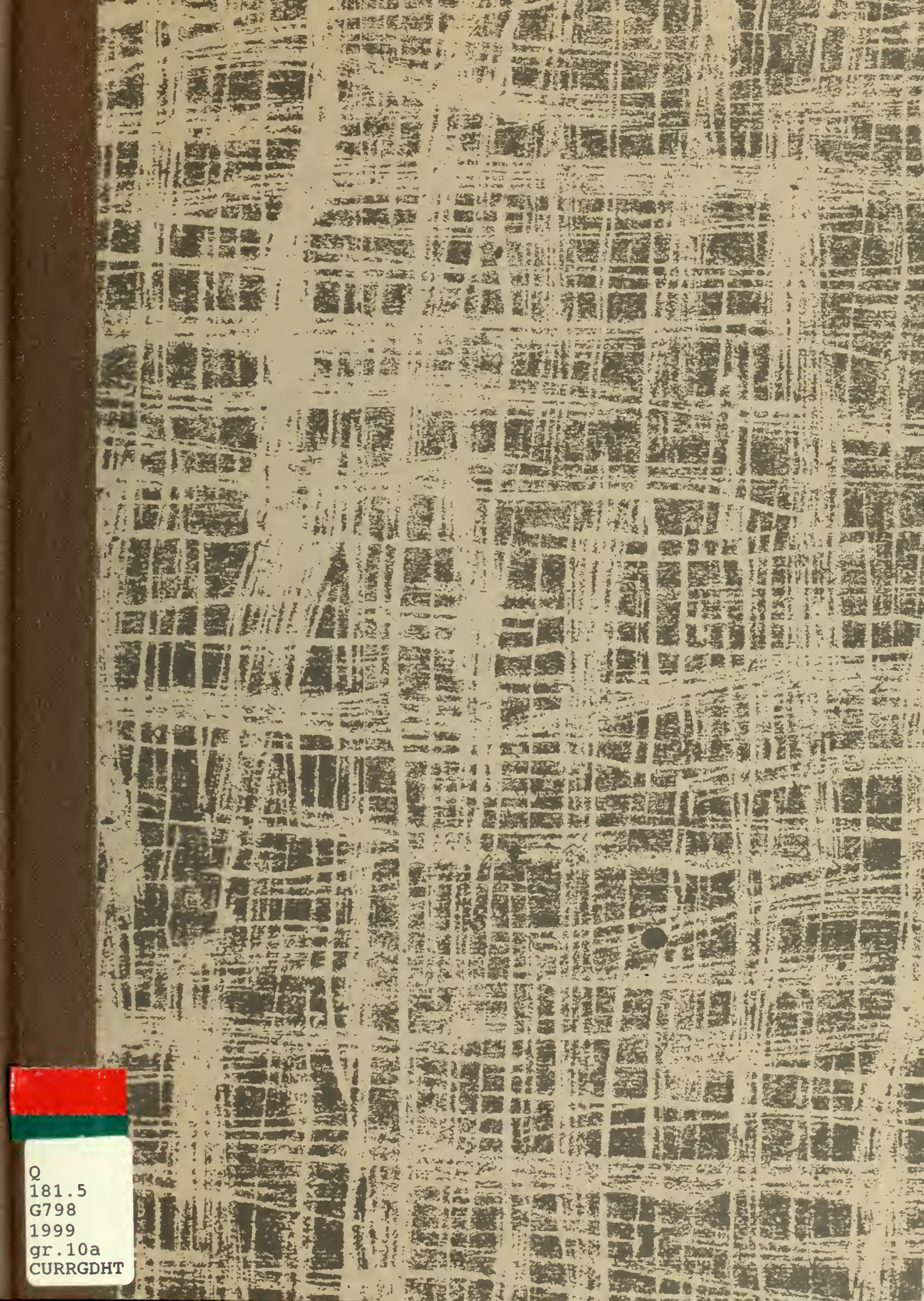

Science 14
Course Outcomes
Second (Validation) Draft

May 1999

Revisions to this second (validation) draft will be made on the basis of classroom field testing and other advice received. Reviewers are encouraged to submit suggestions for improving the clarity of learning outcomes and examples. A resource development draft, incorporating revisions, is scheduled to be made available in November 1999.

Unit Organization

In Grades 7–9, five units of study are outlined at each grade level. At grades 10–12, four units of study are outlined for each grade level. Each unit includes the following components.

Unit Overview

Each unit of study begins with an overview that introduces the contents of the unit and suggests an approach to its development.

Focussing Questions

These questions frame a context for introducing the unit and suggest a focus for investigative activities and application of ideas by students.

Key Concepts

Key concepts identify major ideas to be developed in each unit. Some of the key concepts may be addressed in additional units at the same grade/course level, as well as at other grade/course levels. The intended scope of treatment of these concepts is indicated by the learner outcomes.

Outcomes

Two levels of outcomes are provided in the draft program and courses of study:

- General Outcomes: These are the major outcomes for each unit. For STS and knowledge, the outcomes are combined and unique to each unit. For skills and attitudes, the outcomes are common to all units.
- Specific Outcomes: These are detailed outcomes that flesh out the scope of each unit. They are shown in bulleted form.

Examples

Many of the outcomes are supported by examples. The examples **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed. Illustrative examples are written in *italics* and separated from the outcomes by being placed in parentheses.

Unit Emphases

Each unit of study in secondary science begins with an overview and a set of focussing questions that identify a context for study. In defining the context, one of the following areas of emphasis is identified for each unit.

- *Nature of Science* emphasis: In these units student attention is focused on the processes by which scientific knowledge is developed and tested, and on the nature of the scientific knowledge itself. Skills emphasized in these units are the skills of scientific inquiry.
- *Science and Technology* emphasis: In these units students seek solutions to practical problems by developing and testing prototypes, products and techniques to meet a given need. The skills emphasized are those of problem solving, in combination with the skills of scientific inquiry.
- *Social and Environmental Contexts* emphasis: In these units student attention is focused on issues and decisions relating to how science and technology are applied. Skill emphasis is on the use of research and inquiry skills to inform decisions; students seek and analyze information and consider a variety of perspectives.

Unit A: An Investigation of Matter *(Nature of Science emphasis)*

Overview: The safe handling of chemicals, whether in the home or in the workplace, requires an understanding of the properties of pure substances and mixtures. Students will gain an understanding of these properties by actively investigating a variety of samples of matter, including mixtures and solutions, elements and compounds encountered in everyday life. The atom as the basic building block of matter is introduced. Students also investigate the classification of elements on the periodic table.

Focussing Questions: How do we use properties to classify matter? How can an understanding of the properties of matter be used practically? What is the underlying structure of matter that helps us to classify and understand matter?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade levels. The intended level and scope of treatment is defined by the learning outcomes below.

- ☆ differentiation of matter on the basis of properties
- ☆ solutions and solubility, dilution and concentration
- ☆ measuring concentration
- ☆ preparing solutions, and separating mixtures
- ☆ elements and compounds
- ☆ processes for making agricultural food products
- ☆ safe handling, storage and disposal of household products
- ☆ general knowledge of WHMIS symbols, formulas and nomenclature
- ☆ atoms and the periodic table
- ☆ acids and bases

STS and Knowledge Outcomes

Students will:

1. Classify various forms of matter, including commonly used household substances, on the basis of their properties, and relate these properties to their safe use, storage and disposal
   - describe the need for safety precautions that should be followed when handling, storing and disposing of substances at home and in the laboratory, and explain the WHMIS symbols for labelling substances *(e.g., flammable, corrosive, reactive, health hazard)* **[linked to CTS Course LGS2030: Environmental Law]**
   - differentiate between physical and chemical properties of matter
   - apply the particle nature of matter to explain the physical properties of the phases of matter
   - describe the importance of mixtures and solutions in household products *(e.g., baking soda, soaps, paints)*
   - describe and illustrate, with demonstrations, how the properties of pure substances and mixtures differ *(e.g., flow rates of oil and oil-water emulsions; evaporation of pure water and salt water)*
   - separate mechanical mixtures and solutions on the basis of properties and constituent particles

2. Describe solutions and solubility, solutes and solvents; then apply these concepts to the production of prepared foods and other useful materials
   - provide examples of insoluble and soluble mixtures *(e.g., oil and water; vinegar and water)* and, in general terms, account for the difference *(e.g., investigate how soaps and detergents can dissolve in both)*
   - define, operationally, solute, solvent, solution, solubility

- provide examples of the effect of temperature change on solubility, and explain on the basis of the particle model of matter *(e.g., brines for pickling, syrups for canning, gelatins for dessert)* **[linked to CTS Course FOD3110: Food Processing]**
- provide examples of how solutions are used to lower melting points and increase boiling points *(e.g., putting salt on icy roads, adding antifreeze to car radiators)*
- describe how the solute and solvent in a solution may be separated
- link concentration changes to changes in the ratio of solute to solvent *(e.g., investigate how concentrated products, such as orange juice, evaporated milk or instant coffee, are made; coagulation of proteins in the production of food products, such as cheese and tofu)* **[linked to CTS Course AGR2050: Agrifoods 1 (Materials & Processes)]**
- express the concentration of a solution in terms of mass of solute per volume **[Prerequisite Skill: Grade 7 Mathematics, Strand: Number, SO 18]**
- compare the volume of waste packaging produced from consumer use of the concentrated and diluted forms of products *(e.g., orange juice, fabric softener)* and relate to the need for recycling and environmental preservation **[linked to CTS Course ENM1090: Fundamentals of Recycling]**
- identify acid and base solutions in the home, job site and in the laboratory *(e.g., vinegar, carbonic acid, shampoo, battery acid, household ammonia, antacids, chlorine-based cleaning agents, hydrochloric acid, magnesium hydroxide, sodium hydroxide)* on the basis of their general properties; i.e., they conduct electricity, change colour of indicators and neutralize one another
- describe, in general terms, the pH scale as an indicator of acidity or basicity; i.e., a pH of less than 7 indicates an acid, a pH of 7 indicates a neutral solution, and a pH of greater than 7 indicates a base
- demonstrate the effects of the following environmental factors on the corrosion of iron: acids, bases, salts, humidity and temperature
- list the potential dangers of mixing common household and industrial chemicals *(e.g., mixing ammonia cleaners with bleach, adding muriatic (hydrochloric) acid to caustic soda)*

3. Describe the structure of the atom, and use the periodic table to identify trends in properties
   - describe the atom in terms of protons, neutrons and electrons; and draw analogies to describe the spatial relationships among the parts *(e.g., compared to the whole atom the nucleus is like a pea in the middle of a football field)*
   - differentiate between metals and nonmetals on the basis of properties *(e.g., lustre; conductivity; ability to be bent, hammered into shape or drawn into a wire)*
   - use the periodic table to locate families of elements; i.e., alkali metals, carbon family, halogens, noble gases
   - name and write formulas for common elements *(e.g., aluminum, copper, iron, nitrogen, hydrogen, oxygen)* and simple compounds, and describe their applications in society *(e.g., water, glucose, table salt, carbon dioxide, vinegar, methane, propane)*
   - demonstrate the difference between elements and compounds on the basis of a decomposition reaction *(e.g., electrolysis of water)*

Skill Outcomes *(focus on scientific inquiry)*

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- define questions and problems to facilitate investigation *(e.g., ask how a mixture of salt and water could be separated into its components)*
- state a prediction and a hypothesis based on background information or on an observed pattern of events *(e.g., apply knowledge of the properties of elements to place them on a periodic table)*
- formulate operational definitions of major variables and other aspects of their investigations *(e.g., identify selected solutions and pure substances on the basis of their properties)*
- design an experiment, and identify major variables *(e.g., investigate and classify elements as metals or nonmetals; test various detergents for effectiveness; identify factors that cause corrosion in iron)*
- select appropriate methods and tools for collecting data and information to solve problems *(e.g., separate a mixture using standard techniques, such as filtration, evaporation, crystallization or chromatography)*

Performing and Recording

Students will:

Conduct investigations into relationships between and among observations, and gather and record qualitative and quantitative data

- carry out procedures, controlling the major variables *(e.g., investigate properties, such as physical appearance, density, conductivity, solubility, magnetism and melting point, of samples of pure substances and mixtures in the laboratory and in a reference source, and tabulate the results)*
- organize data, using a format that is appropriate to the task or experiment *(e.g., prepare a chart that describes the properties of common household solutions, and list procedures for their safe use, storage and disposal)*
- select and integrate information from various print and electronic sources or from several parts of the same source *(e.g., use current, reliable information sources from around the world to investigate atoms and molecules; upload and download text, image, audio and video files on the safe handling of chemicals in the workplace)*

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- use or construct a classification key *(e.g., identify selected solutions and pure substances on the basis of their properties)*
- predict the value of a variable, by interpolating or extrapolating from graphical data *(e.g., demonstrate that the solubility of substances varies directly with the temperature)* **[Prerequisite Skill: Grade 7 Mathematics, Strand: Patterns and Relations, SO 2]**
- interpret patterns and trends in data, and infer and explain relationships among the variables *(e.g., demonstrate that the solubility of substances varies with the nature of the solute and the solvent and with the temperature)* **[Prerequisite Skill: Grade 7 Mathematics, Strand: Statistics and Probability, SO 5]**
- identify potential sources of error in the measurement *(e.g., qualitatively estimate the concentration of a solution from its colour)*
- state a conclusion based on experimental data, and explain how evidence gathered supports or refutes the initial hypothesis *(e.g., observe Brownian movement or the Tyndall effect, and explain how these observations support the particle model of matter)*

- identify and evaluate potential applications of findings *(e.g., relate the use of standard laboratory separation techniques to the processes used in the manufacture of orange juice, instant coffee, evaporated milk, cheese, tofu)*

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others *(e.g., share information and learn from others)*
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means *(e.g., construct a model or write a paragraph to describe the structure of the atom; use IUPAC nomenclature to name simple and common elements and compounds)*
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise *(e.g., compare the volume of waste packaging produced by concentrated and diluted forms of products, such as fabric softener, juice, cleaning products)*

Attitude Outcomes

Appreciation of Science

Students will be encouraged to:

- value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not *(e.g., appreciate how scientific problem solving and the development of new technologies are related; recognize the contribution of science and technology to the progress of civilizations)*

Interest in Science

Students will be encouraged to:

- show a continuing and more informed curiosity and interest in science and science-related issues *(e.g., research the answers to their own questions, such as "What is the pH of the shampoo and other cleaning solvents used in my home?")*
- consider further studies and careers in science- and technology-related fields (*e.g., recognize that part-time jobs require science- and technology-related knowledge and skills)*

Scientific Attitudes

Students will be encouraged to:

- use factual information and rational explanations when analyzing and evaluating *(e.g., critically evaluate inferences and conclusions)*
- value the processes for drawing conclusions *(e.g., ask questions and do research to ensure they understand)*

Collaboration

Students will be encouraged to:

- work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas *(e.g., willingly work with any classmate or group of individuals, regardless of their age, gender, or physical and cultural characteristics; share the responsibility for errors made or difficulties encountered by the group)*

Stewardship and Ethical Behaviour

Students will be encouraged to:

- have a sense of personal and shared responsibility for maintaining a sustainable environment *(e.g., assume part of the collective responsibility for the impact of humans on the environment)*
- project the personal, social and environmental consequences of proposed action *(e.g., consider the impact of technologies, weighing scientific, technological and ecological factors)*

Safety

Students will be encouraged to:

- show concern for safety, and accept the need for rules and regulations *(e.g., read the label on materials before using them, interpret the WHMIS symbols and consult a reference document if safety symbols are not understood; seek assistance immediately for any first aid concerns, such as cuts, burns or unusual reactions)*
- be aware of the direct and indirect consequences of their actions *(e.g., evaluate the long-term impact of waste disposal, such as paints and cleaning solutions, on the environment and the quality of life of living organisms)*

Unit B: Understanding Energy Transfer Technologies *(Science and Technology emphasis)*

Overview: At home or at work, energy can be transferred by means of thermal energy and by use of force or distance multipliers called machines. The optimal design of such energy transfer technologies is based upon an understanding of energy transfer, heat and temperature, and force. Students will gain an understanding that the design of energy transfer technologies also takes into consideration the need for safety and for efficiency as a means to reduce reliance upon nonrenewable energy resources.

Focussing Questions: How do common energy transfer technologies work in meeting our daily needs? Why are efforts to promote energy conservation, by improving the efficiency of these technologies, important to society?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade levels. The intended level and scope of treatment is defined by the learning outcomes below.

- ☆ radiation, convection, conduction
- ☆ particle model of matter
- ☆ temperature and heat
- ☆ heat flows from warm objects to cold objects
- ☆ heat can be quantified
- ☆ methods to reduce the loss of heat in homes and buildings
- ☆ heat capacity and related technologies
- ☆ simple machines as force or distance multipliers that transfer energy
- ☆ energy transfer = Fd
- ☆ reducing reliance on nonrenewable energy sources

STS and Knowledge Outcomes

Students will:

1. Describe how natural and technological cooling and heating systems are based upon the transfer of heat from hot to cold objects
   - describe the three ways; i.e., radiation, conduction and convection, that heat is transferred from hot to cold objects
   - observe and explain the functioning of cooling systems as applications that are based on the principles of heat transfer *(e.g., fins on engines, piping on the back of refrigerators and air conditioners, automobile radiators)* **[linked to CTS Courses ENM2090: Energy Designs/Systems 1 (Basic Principles) and ENM3090: Energy Designs/Systems 2 (Practical Applications)]**
   - describe the model of matter in which every object consists of particles in motion, by observing Brownian motion and the effect of temperature on this motion
   - demonstrate that when heat is transferred from hot objects to cold objects, energy is conserved
   - describe the role of convection and conduction in distributing heat in natural and technological systems *(e.g., weather phenomena, convection ovens, metal pipes, cast iron pots and pans)*

2. Explain the functioning of common means and devices designed to control the transfer of heat
   - quantify the change in temperature of an object being heated or cooled, by manipulating variables that include the amount and type of material
   - explain how large bodies of water, such as oceans and lakes, have a moderating influence on climate
   - explain the functioning of insulation, cavity walls, aluminum foil and double glazing in reducing heat transfer, by constructing a container to keep a material hot or cold **[linked to CTS Course CON3080: Energy-efficient Housing]**

- describe the functioning of devices and methods that protect against potentially dangerous heat transfer *(e.g., in household appliances, protective clothing worn by firefighters, internal combustion engine)* **[linked to CTS Courses ENM2090: Energy Designs/Systems 1 (Basic Principles), ENM3090: Energy Designs/Systems 2 (Practical Applications) and MEC2030: Lubrication & Cooling]**
- explain the role of specific heat capacity in determining the choice of engine coolants **[linked to CTS Course MEC2030: Lubrication & Cooling]**

3. Describe and compare machines as devices that transfer energy and multiply forces or distances
   - analyze and describe machines as devices that transfer energy
   - analyze and describe machines as either force multipliers or distance multipliers
   - identify most machines as force multipliers that make lives easier for all
   - describe all machines as having an input force and output force
   - explain how the human body is analogous to a machine
   - measure the force (F) applied to the object and the distance (d) the object is moved in the direction in which the force is applied
   - identify the SI unit of energy as the Joule, named in honour of Prescott Joule
   - develop the relationship Fd, using a balance beam (teeter-totter) to establish equilibrium and using differing masses at different distances **[Prerequisite Skill: Grade 7 Mathematics, Strand: Patterns and Relations, SO 6]**
   - explain the functioning of common household machines, in terms of force multipliers and ways in which work is made easier *(e.g., can openers, crowbars, car jacks, scissors and hedge clippers)*
   - explain the need to encourage and support the development of machines that are efficient and rely upon renewable energy *(e.g., hand wound or solar-powered radio, solar assisted devices)* **[linked to CTS Course ENM1050: Renewable Resources]**

Skill Outcomes *(focus on problem solving)*

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- rephrase questions in a testable form, and clearly define practical problems
- identify questions to investigate arising from practical problems and issues *(e.g., investigate the functioning of common machines, such as car jacks, can and bottle openers, meat grinders, bicycles, ramps and others that either convert a force into another force having a different direction, or convert a force to a faster or slower force, or convert a force to a larger or smaller force)*
- propose alternative solutions to a given practical problem, select one and develop a plan *(e.g., identify ways to reduce thermal energy loss or gain in school buildings)*
- state a prediction and a hypothesis based on background information or on an observed pattern of events *(e.g., hypothesize upon the relationship between the rate of thermal conduction in different materials and their insulative properties)*
- design an experiment, and identify major variables *(e.g., design and perform an experiment to measure temperature changes in different liquids, identifying variables and controls; include the procedure, required observation tables or charts, possible sources of error and their effects on the results)*

Performing and Recording

Students will:

Conduct investigations into relationships between and among observations, and gather and record qualitative and quantitative data

- estimate measurements *(e.g., predict the final temperature when two samples of water of equal and unequal mass are mixed at different temperatures; use SI units and unit analyses)* **[Prerequisite Skills: Grade 7 Mathematics, Strand: Number, SO 14 and Grade 8 Mathematics, Strand: Number, SO 14]**
- use instruments effectively and accurately for collecting data *(e.g., collect data on daily household energy consumption, by recording electricity and gas meter reading over a two-week period; organize and analyze the data)* **[Prerequisite Skill: Grade 7 Mathematics, Strand: Statistics and Probability, SO 5]**
- use tools, technology and apparatus safely *(e.g., safely perform an experiment to compare the thermal conduction rate of different materials)*

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- interpret patterns and trends in data, and infer and explain relationships among the variables *(e.g., suggest the reasons for daily fluctuations in domestic energy consumption)*
- calculate theoretical values of a variable *(e.g., calculate energy transferred, force (F) or distance (d), when two quantities and the equation (energy transferred = Fd) are given, for a number of actual situations)* **[Prerequisite Skill: Grade 7 Mathematics, Strand: Patterns and Relations, SO 6]**
- identify and evaluate potential applications of findings *(e.g., perform an experiment to investigate how well various materials insulate; graph the temperature changes and rank commonly available insulating materials from the most to the least effective, for use in building construction)*
- test the design of a constructed device or system *(e.g., construct a model wall, roof, floor or windows to test the effectiveness of several methods of insulating homes; evaluate insulating materials, such as brick, stone, straw, wood or paper)*
- identify and correct practical problems in the way a prototype or constructed device functions *(e.g., analyze a device constructed to retain heat or keep objects cool over a period of time)*
- evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment *(e.g., test insulation materials and methods)*

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others *(e.g., revise text documents based on feedback from others)*
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means *(e.g., draw diagrams that show the differences between particles in solids, liquids and gases; communicate, using the following terms: thermal energy, temperature and specific heat capacity; observe and accurately record the motion of smoke particles)*

Attitude Outcomes

Appreciation of Science

Students will be encouraged to:

- value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not *(e.g., appreciate how scientific problem solving and the development of new technologies are related; recognize the usefulness of being skilled in mathematics and problem solving)*
- value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds *(e.g., recognize that the modern western approaches to technology are not the only ways by which people, such as aboriginals, have met their needs)*

Interest in Science

Students will be encouraged to:

- acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research *(e.g., explore and use a variety of methods and resources to increase their own knowledge and skills and to solve problems)*
- consider further studies and careers in science- and technology-related fields *(e.g., recognize that part-time jobs require science- and technology-related knowledge and skills)*

Scientific Attitudes

Students will be encouraged to:

- evaluate and consider, with confidence, alternative perspectives, ideas and explanations *(e.g., critically assess their opinion of the value of science and its applications)*
- use factual information and rational explanations when analyzing and evaluating *(e.g., ask questions and do research to ensure they understand)*

Collaboration

Students will be encouraged to:

- work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas *(e.g., seek the point of view of others, and consider a multitude of perspectives; accept constructive criticism when sharing their ideas or points of view; criticize the ideas of their peers without criticizing the individuals)*

Stewardship and Ethical Behaviour

Students will be encouraged to:

- have a sense of personal and shared responsibility for maintaining a sustainable environment *(e.g., willingly promote actions and technologies that are not injurious to the environment)*
- project the personal, social and environmental consequences of proposed action *(e.g., consider the impact of technology, weighing scientific, technological and ecological factors)*
- want to take action for maintaining a sustainable environment *(e.g., participate in the social and political systems that influence environmental policy in their community)*

Safety

Students will be encouraged to:

- show concern for safety, and accept the need for rules and regulations *(e.g., keep the work station uncluttered, with only appropriate materials present; consider safety a positive limiting factor in scientific and technological endeavours)*

Unit C: Investigating Matter and Energy in Living Systems *(Science and Technology emphasis)*

Overview: Life processes require the exchange of matter between living systems and the external environment. Students will investigate the life processes at the cellular level and extrapolate these processes to the human digestive and circulatory systems. By investigating the digestive and circulatory systems, students will better understand the need for a healthy diet and lifestyle as being crucial to their wellness.

Focussing Questions: In what ways are cells, that are microscopic and invisible to the naked eye, similar to the larger and visible systems, such as organs? What lifestyle choices can be made to help our organs and organ systems function optimally?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade levels. The intended level and scope of treatment is defined by the learning outcomes below.

- ☆ living systems are composed of cells
- ☆ structure and function of plant and animal cells
- ☆ role of technology in the emergence of cell theory
- ☆ viewing cells through the microscope
- ☆ common life functions of cells and organ systems
- ☆ functions and relationship between digestive and circulatory systems
- ☆ food molecules and enzymes
- ☆ diets and human nutritional needs
- ☆ social influences on human dietary-induced disorders and circulatory diseases

STS and Knowledge Outcomes

Students will:

1. Describe, in general terms, the structure and function of plant and animal cell structures, and trace the development of the cell theory
   - relate our knowledge of cells to the development of the optical microscope and staining techniques *(e.g., the work of van Leeuwenhoek, Robert Hooke)*
   - describe the structure of the major parts of plant and animal cells, including the cell membrane, nucleus, vacuole, mitochondrion, chloroplast and cell wall, where present
   - describe, using analogies where appropriate, the functions of the cell membrane, nucleus, vacuole, mitochondrion, chloroplast and cell wall, of plant and animal cells

2. Identify and compare, in general terms, the life functions common to living systems, from cells to organ systems
   - identify life functions common to living systems; i.e., energy conversion, transformation of matter, movement of matter, response to the environment, growth, reproduction
   - relate knowledge about life functions to organs and systems in plants and animals
   - design models of cells that deal with specific life functions *(e.g., water balance, impulse transmission, structural support)*
   - identify the major human organ systems that perform critical life functions; i.e., energy conversion, transformation of matter, movement of matter, response to the environment, growth, reproduction

- identify and describe the role of modern technology in monitoring critical life functions in humans *(e.g., telemetry, heart monitor, endoscope)* **[linked to CTS Course CMH3110: Advances in Medical Technology]**

3. Describe, in general terms, the exchange of matter by the digestive and circulatory systems, the functional relationship between the two systems and the need for a healthy diet and lifestyle
   - assess the nutrient components of prepared foods from reading labels, and evaluate a variety of popular diets in terms of nutrient components **[linked to CTS Courses CMH1080: Perspectives on Health, FOD2010: Food & Nutrition Basics and FOD2130: Vegetarian Cuisine]**
   - describe, in general terms, the intake of matter and its processing by the digestive system
   - describe, in general terms, the role of the heart and lungs in the circulatory system and in the exchange and distribution of matter
   - analyze the functional relationship between the digestive and circulatory systems **[linked to CTS Course CMH3080: Digestive System]**
   - summarize how the work of early physicians advanced our understanding of human body systems *(e.g., William Harvey, Ivan Pavlov, William Beaumont)*
   - explain how diets that include excessive amounts of certain foods may influence body function *(e.g., cholesterol, salt, fats)* **[linked to CTS Courses CMH1080: Perspectives on Health, FOD2010: Food & Nutrition Basics and FOD2130: Vegetarian Cuisine]**
   - analyze and discuss mixed diets and vegetarian diets in meeting human nutritional needs **[linked to CTS Courses CMH1080: Perspectives on Health, FOD2010: Food & Nutrition Basics and FOD2130: Vegetarian Cuisine]**

4. Describe the disorders of the digestive and circulatory systems as imbalances induced by illness or lifestyle choices
   - describe, in general terms, how the digestive and circulatory systems interact to assist in the maintenance of balance (homeostasis) in the human organism
   - explain how normal fluctuations within the digestive system result in adjusting fluctuations in the circulatory system *(e.g., ingestion of too much salt can result in increased blood pressure; blood stream carries hormones that affect the digestive system)*
   - explain that illness and possibly death may result when the body cannot accommodate major disturbances within a system; i.e., digestive or circulatory **[linked to CTS Course CMH3080: Digestive System]**
   - analyze and explain, in general terms, a technology that is used to diagnose or intervene and preserve balance (homeostasis) *(e.g., heart and lung machine, pacemaker, artificial heart)* **[linked to CTS Course CMH3110: Advances in Medical Technology]**
   - evaluate the effect of social factors on human digestive and circulatory well-being and disorders *(e.g., ulcers, anorexia, bulimia, high blood pressure, heart and arterial diseases, fitness, longevity, balanced diets)* **[linked to CTS Courses CMH1080: Perspectives on Health and FOD2030: Food Decisions & Health]**

Skill Outcomes *(focus on problem solving)*

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- rephrase questions in a testable form, and clearly define practical problems *(e.g., "Is there a relationship between social attitudes and diet?", "What design features would a device have in order to listen to a heart beat?")*

- identify questions to investigate arising from practical problems and issues *(e.g., plan and conduct a search, using a wide variety of electronic sources, when investigating technology used to monitor critical life functions)*
- propose alternative solutions to a given practical problem, select one and develop a plan *(e.g., build a device that magnifies objects or could be used to monitor human health)*

Performing and Recording

Students will:

Conduct investigations into relationships between and among observations, and gather and record qualitative and quantitative data

- carry out procedures, controlling the major variables *(e.g., perform experiments that demonstrate diffusion rate, and communicate this information graphically; identify the manipulated, responding and controlled variables for an experimental investigation exercise on heart rate)*
- estimate measurements *(e.g., calculate the magnification from knowledge of the microscope)* **[Prerequisite Skills: Grade 8 Mathematics, Strand: Number, SO 12 and Strand: Shape and Space, SO 11]**
- use instruments effectively and accurately for collecting data *(e.g., prepare wet mounts of tissue, and observe cellular structures specific to plant cells and animal cells; observe structures using photomicrographs)*
- organize data, using a format that is appropriate to the task or experiment *(e.g., determine the nutrient components in popular diets)*
- select and integrate information from various print and electronic sources or from several parts of the same source *(e.g., use models, computer simulations or dissected organisms to observe the gross anatomy of the digestive and circulatory systems [this requires that students have a general understanding of the system anatomy but does not require detailed knowledge and terminology of each of the systems])*
- use tools and apparatus safely *(e.g., stain a variety of animal and plant cells, use the compound microscope to identify cellular structures from prepared slides of plant and animal tissue or microslides, and accurately represent these structures in clearly labelled diagrams)*

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea *(e.g., observe cytoplasmic streaming in the paramecium, and compare this method of matter distribution to that in multicellular living systems, such as the human organism; observe the feeding behaviour of paramecium, and compare this to the processes that occur in the human organism)*
- critique the design of a constructed device or system *(e.g., model of cell, stethoscope)*
- identify and correct problems in the way a prototype or constructed device functions *(e.g., models of cells that perform a specific function)*
- evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment *(e.g., a device built to monitor life functions)*
- identify new questions and problems that arise from what was learned *(e.g., "How do water and dissolved materials move in living plant and animal cells?")*

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others *(e.g., revise designs of prototypes, based on the feedback of others)*
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means *(e.g., research and identify the cause and physiological basis of a specific disorder in one of the systems studied; present this information orally to peers or in a document, using style sheets and with attention to page layout that incorporates advanced word processing techniques, including headers, footers, margins, columns, bibliography, index, table of contents)*
- defend a given position on an issue or problem, based on their findings *(e.g., research how individual lifestyles [e.g., smoking, inactivity, stress] and eating habits [e.g., fatty diet] affect the functioning of the circulatory system; and take a position on whether individuals should or should not be coerced into healthier lifestyles)*

Attitude Outcomes

Appreciation of Science

Students will be encouraged to:

- value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not *(e.g., appreciate how scientific problem solving and the development of new technologies are related; recognize the contribution of science and technology to the progress of civilizations)*
- value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds *(e.g., use a multi-perspective approach, considering scientific, technological, economic, cultural, political and environmental factors when formulating conclusions on the impact of western/nonwestern diets on human health)*

Interest in Science

Students will be encouraged to:

- show a continuing and more informed curiosity and interest in science and science-related issues *(e.g., research the answers to their own questions)*
- acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research *(e.g., readily investigate ways to improve the functioning of circulatory and digestive systems)*

Scientific Attitudes

Students will be encouraged to:

- evaluate evidence confidently, and consider alternative perspectives, ideas and explanations *(e.g., insist that the critical assumptions behind any line of reasoning be made explicit, so that the validity of the solution can be judged)*

- use factual information and rational explanations when analyzing and evaluating *(e.g., criticize arguments in which evidence, explanations or positions do not reflect the diversity of perspectives that exist)*

Collaboration

Students will be expected to:

- work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas *(e.g., provide the same attention and energy to the group's product as to a personal assignment; criticize the ideas of peers without criticizing individuals)*

Stewardship and Ethical Behaviour

Students will be expected to:

- project the personal, social and environmental consequences of proposed action *(e.g., consider all perspectives when addressing issues, weighing scientific, technological and ecological factors)*

Safety

Students will be encouraged to:

- show concern for safety, and accept the need for rules and regulations *(e.g., keep the work station uncluttered, with only appropriate materials present)*

Unit D: Investigating Matter and Energy in the Environment *(Social and Environmental Contexts emphasis)*

Overview: Energy from the Sun sustains living systems in the biosphere and maintains equilibrium in the biosphere. Within the biosphere, matter is recycled along characteristic pathways that are influenced by living organisms. Students will become aware of the growing human population and the increasing reliance on manufactured materials. They will also learn that the cycling of waste matter in the environment has become a societal issue. To meet the needs of a growing human population, the natural flow of matter and energy in ecosystems is being disrupted. This disruption has given rise to global concerns about the sustainability of the biosphere and has heightened awareness of the need to protect the environment by making judicious use of natural resources.

Focussing Questions: How is human activity influencing the natural flow of matter and energy in the biosphere? Should humans as a species be concerned about the effects of our activities on other species and the environment?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade levels. The intended level and scope of treatment is defined by the learning outcomes below.

- ☆ noncyclic flow of energy through the biosphere
- ☆ storage and use of energy by photosynthesis and respiration
- ☆ strategies by living organisms to store or use energy
- ☆ environmental laws to maintain equilibrium in the biosphere
- ☆ role of living organisms in cycling matter
- ☆ biodegradable materials and the impact of modern agricultural technologies
- ☆ biotic and abiotic factors and ecosystems
- ☆ field study of ecosystems
- ☆ factors affecting population growth
- ☆ impact of exotic species on ecosystems
- ☆ recycling of human-generated wastes

STS and Knowledge Outcomes

Students will:

1. Describe how the processes of photosynthesis and respiration, processes that maintain the balance of energy, can be disrupted by human activity
   - describe how biological energy storage is maintained by a balance between photosynthesis and respiration
   - summarize alternative strategies developed by living organisms to conserve or dissipate thermal energy *(e.g., torpor, dormancy, hibernation, estivation, vascular skin, sweat glands, behaviour)*
   - summarize strategies developed by vascular plants to increase the storage of solar energy *(e.g., sugar cane, sugar beets and apples)*
   - explain why the flow of energy through the biosphere is noncyclical

2. Describe how the flow of matter in the biosphere is cyclical along characteristic pathways and can be disrupted by human activity
   - explain the role of living systems in the cycling of matter in the biosphere *(e.g., saprophytes)*
   - assess the costs and benefits of technological developments that produce materials the ecosystem cannot recycle *(e.g., plastics, heavy metals)* **[linked to CTS Course ENM1090: Fundamentals of Recycling]**
   - explain how biodegradable materials reduce the impact of human-made products on the environment **[linked to CTS Course ENM1090: Fundamentals of Recycling]**

- describe, in general terms, how water, carbon, oxygen and nitrogen are cycled through the biosphere **[linked to CTS Course AGR3110: Water Management]**
- compare the recycling of matter by society with natural cycling of matter through ecosystems **[linked to CTS Course ENM1090: Fundamentals of Recycling]**
- assess the impact of modern agricultural technology on the carbon cycle **[linked to CTS Course AGR1100: Agriculture Technology]**
- identify and assess the needs and interests of society that led to a technology with unforeseen environmental consequences *(e.g., freon refrigeration technology and ozone depletion)* **[linked to CTS Course LGS2030: Environmental Law]**
- assess the impact of society and human activities on atmospheric compositions *(e.g., destruction of forests, desertification)*

3. Analyze a local ecosystem in terms of its biotic and abiotic components, and describe factors contributing to population growth and the impact of uncontrolled growth on this ecosystem
   - describe, in general terms, the characteristics of two Alberta biomes
   - define ecosystems in terms of biotic and abiotic factors
   - describe how various abiotic factors influence biodiversity in an ecosystem *(e.g., climate, substrate temperature, elevation, topography)*
   - explain how the biotic relationships can be explained in terms of the movement of matter and energy, using food chains, webs and energy pyramids
   - explain the various factors that influence the growth of populations; i.e., migration, birth rate, mortality
   - describe how interactions among organisms limit populations *(e.g., predation, parasitism and competition)*
   - discuss whether extinction is a natural phenomenon
   - assess the impact of the introduction of exotic species on a specific ecosystem or biome *(e.g., purple loosestrife in Western Canadian lakes, English sparrows in North America, rabbits in Australia, zebra mussels in the Great Lakes)*
   - describe the relationship between land use practices and endangering ecosystems *(e.g., swamp drainage, slash and burn forest agriculture)* **[linked to CTS Course AGR3010: Issues in Agriculture]**
   - trace the development of a scientific or technological application that has created or intensified problems in the biosphere *(e.g., hydroelectric power dams, dioxins, hydrogen sulfide, herbicides and pesticides)* **[linked to CTS Courses ENM1050: Renewable Resources and ENM3010: Energy & the Environment]**

Skill Outcomes *(focus on applying science to inform decision-making processes)*

Initiating and Planning

Students will:

Ask questions about relationships between and among observable variables, and plan investigations to address those questions

- identify questions to investigate arising from practical problems and issues *(e.g., develop questions related to recycling, ozone depletion or introduction of exotic species)*
- define questions and problems to facilitate investigation *(e.g., develop questions to guide investigations on composting, recycling, impact of farming practices on local ecosystems)*

- design an experiment, and identify manipulated, responding and controlled variables *(e.g., investigate the amount of waste materials produced by their school or family on a daily or weekly basis)*
- select appropriate methods and tools for collecting data and information to solve problems *(e.g., plan and conduct a search, using a wide variety of electronic sources)* **[Prerequisite Skills: Grade 7 and Grade 8 Mathematics, Strand: Statistics and Probability, SO 2]**

Performing and Recording

Students will:

Conduct investigations into relationships between and among observations, and gather and record qualitative and quantitative data

- carry out procedures, controlling the major variables *(e.g., perform quantitative experiments to demonstrate that cellular respiration releases some energy in the form of thermal energy)*
- estimate measurements *(e.g., collect quantitative data, using microorganisms [hay infusions, pond water samples, fruit flies], that demonstrate how closed populations of organisms change over time; present the data in tables, graphs or charts)*
- organize data, using a format that is appropriate to the task or experiment *(e.g., analyze the biotic and abiotic data collected in an ecosystem study, and present this information in a written or graphic format or in an oral presentation to peers)* **[Prerequisite Skills: Grade 7 Mathematics, Strand: Patterns and Relations, SO 3 and Strand: Statistics and Probability, SO 9]**
- select and integrate information from various print and electronic sources *(e.g., research the influence of a specific living organism [nitrogen bacteria, sulfur bacteria, sea birds, mollusks] on the cycling of matter through the biosphere, and communicate information in the form of a clearly written report)*
- use tools, technology and apparatus safely *(e.g., perform a field study on an aquatic or terrestrial ecosystem; and measure, quantitatively, appropriate abiotic data [temperature, humidity, precipitation, light intensity, pH, hardness, oxygen content])* **[Prerequisite Skills: Grade 7 Mathematics, Strand: Patterns and Relations, SO 3 and Strand: Statistics and Probability, SO 9]**

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs and scatterplots *(e.g., research the flow of energy from the Sun through the biosphere; and communicate this information by tracing this flow of energy, using a diagram or flow chart)* **[Prerequisite Skill: Grade 8 Mathematics, Strand: Statistics and Probability, SO 3]**
- identify strengths and weaknesses of different methods of collecting and displaying data *(e.g., analyze methods used to collect and display biotic and abiotic data for an ecosystem)*
- apply given criteria for evaluating evidence and sources of information *(e.g., assess the authority and reliability of print and electronic sources on the basis of provided criteria)*
- state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea *(e.g., explain, on the basis of experimental evidence, how energy is stored in the form of starch in photosynthetic organisms)*
- identify and evaluate potential applications of findings *(e.g., experimentally determine the biodegradability of various forms of organic matter, and relate findings to composting and recycling)*

- identify new questions and problems that arise from what was learned *(e.g., "Should there be more controls on bringing live animals and plants to Canada from the United States and other countries?", "How can we reduce the amount of household wastes?")*

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others *(e.g., revise text documents, based on feedback from others)*
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means *(e.g., represent the movement of matter and energy in an ecosystem, using food chains, webs or pyramids, and communicate this information in the form of a graphic illustration; describe the biogeochemical cycles of carbon, nitrogen or oxygen, and communicate this information in clearly labelled charts, models or diagrams)*
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise *(e.g., perform a field study on an aquatic or terrestrial ecosystem)*
- evaluate individual and group processes used in planning, problem solving, decision making and completing a task
- defend a given position on an issue or problem, based on their findings *(e.g., investigate reduction of household wastes and ways to prevent the introduction of exotic species into Alberta or Canada)*

Attitude Outcomes

Appreciation of Science

Students will be encouraged to:

- appreciate that the applications of science and technology can raise ethical dilemmas *(e.g., carefully research and openly discuss ethical dilemmas associated with the application of science and technology)*
- value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not *(e.g., consider scientific, technological, economic, cultural, political and environmental factors when formulating conclusions, solving problems or making decisions on an STS issue)*

Interest in Science

Students will be encouraged to:

- show a continuing and more informed curiosity and interest in science and science-related issues *(e.g., demonstrate an interest in science and technology topics not directly related to their formal studies)*
- acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research *(e.g., readily investigate STS issues)*

Scientific Attitudes

Students will be encouraged to:

- evaluate evidence confidently, and consider alternative perspectives, ideas and explanations *(e.g., insist on evidence before accepting a new idea or explanation)*
- use factual information and rational explanations when analyzing and evaluating *(e.g., insist on evidence before accepting a new idea or explanation)*
- value the processes for drawing conclusions *(e.g., insist that the critical assumptions behind any line of reasoning be made explicit, so that the validity of the position taken can be judged)*

Collaboration

Students will be encouraged to:

- work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas *(e.g., be attentive when others speak; be capable of suspending personal views when evaluating suggestions made by a group; be nonjudgmental in the discussion of ideas and plans)*

Stewardship and Ethical Behaviour

Students will be encouraged to:

- have a sense of personal and shared responsibility for maintaining a sustainable environment *(e.g., willingly promote actions that are not injurious to the environment; make personal decisions based on feelings of responsibility toward less privileged parts of the global community and toward future generations)*
- project the personal, social and environmental consequences of proposed action
- want to take action for maintaining a sustainable environment *(e.g., participate in the social and political systems that influence environmental policy in their community)*

Safety

Students will be encouraged to:

- be aware of the direct and indirect consequences of their actions *(e.g., examine their personal role in the preservation of the environment)*